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PATENT

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Elizabeth A. Jue

Applicant	:	Timothy Dawson
Application No.	:	09/917,192
Filed	:	July 27, 2001
Title	:	DOOR MODULE
Grp./Div.	:	3634
Examiner	:	Jerry E. Redman
Docket No.	:	46918/M521

Confirmation No. 9619

SUBMISSION OF APPELLANT'S BRIEF UNDER §1.192 TO THE BOARD OF PATENT APPEALS AND INTERFERENCES

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Post Office Box 7068
Pasadena, CA 91109-7068
March 30, 2006

Commissioner:

Enclosed for filing is the Appellant's Brief for this application.

______ An extension of time to file Appellant's _ is requested, and a Petition for Extension of Time and the applicable fee are enclosed.

__X__ Our check for $500 to cover the fee for the appeal brief is enclosed.

______ An oral hearing of the appeal is requested, and our check for $_, the fee for the oral hearing, is enclosed.

Application No. 09/917,192

The Commissioner is hereby authorized to charge any further fees under 37 CFR 1.16 and 1.17 which may be required by this paper to Deposit Account No. 03-1728. Please show our docket number with any charge or credit to our Deposit Account. **A copy of this letter is enclosed.**

Respectfully submitted,

CHRISTIE, PARKER & HALE, LLP

By ______________________________
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APPELLANT'S BRIEF

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Commissioner:

1. REAL PARTY IN INTEREST

Brose Fahrzeugteile GmbH & Co. KG, Coburg is the real party in interest.

2. RELATED APPEALS AND INTERFERENCES

None.

3. STATUS OF CLAIMS

Claims 15-22 are cancelled. Claims 1-14 and 23-33 rejected. Claims 1-14 and 23-33 are appealed.

4. STATUS OF AMENDMENTS

There is no final rejection outstanding with respect to this application. At least one claim has been rejected twice in this application. No amendments have been filed after the filing of the Notice of Appeal.

5. SUMMARY OF CLAIMED SUBJECT MATTER

In general, the application is directed to a door module, a compression moulding set for manufacturing a door module, and a process of manufacturing a door module.

Independent claims 1, 23, 32, and 33 are involved in the appeal. A concise explanation of the subject matter defined in each of these claims is set forth below. This concise explanation of the subject matter defined in each of the independent claims is for the convenience of the Board, as required by 37 C.F.R. § 41.37(c)(v), and is not intended and should not be used to interpret the language of the claims or broaden or narrow the scope of such claims. References to the specification and drawings are also provided as examples and for convenience, as required by 37 C.F.R. § 41.37(c)(v), and are not intended and should not necessarily be interpreted as a complete recitation of all instances in the specification and drawings relevant to the claim element(s) corresponding to such reference. Similarly, references to the specification or drawings do not imply that the portions referenced necessarily fall within or outside of the scope of the claim element(s) corresponding to such reference. References to the specification refer to the Substitute Specification submitted on November 14, 2001 and are in the form of [page]:[line]-[line] or [page]:[line]-[page]:[line]. References to the drawings are in the form of FIG. [num]: [reference numeral], [reference numeral] . . . .

Claim 1 - A door module for covering a surface cut-out recess in an inside panel of a vehicle door includes a substantially rigid portion of long glass fiber reinforced plastic. 1:30-2:2; 3:4-8; 6:13-19; 9:23-24; 9:27-10:2; FIG. 1:1-4; FIGs. 2a-4:2, 4, 12; FIGs. 5, 8a-10:4; FIGs. 11-12:4, 26. The door module also includes a substantially elastic portion of plastic substantially free of long glass fibers. 1:30-32; 2:1-9, 13-16, 20-31; 3:14-16, 26-30; 4:6-8; 6:30, 7:1-5, 13-27; 8:2-4, 6-14, 16-21; 9:19-21, 27-31; 10:1-19; FIG. 1:9; FIGs. 2a-2b:8, 9; FIGs. 3-5:8; FIGs. 8a-8b:22; FIG. 9:24; FIG. 10:23; FIGs. 11-12:27. The substantially rigid portion and the

substantially elastic portion are formed in one piece. 1:30-32; 2:1-2; 4:1-10; 8:23-30; 9:1-3, 23-31; 10:12-19; FIGs. 2a-4:4, 8; FIG. 5:4, 14; FIGs. 8a, 8b:4, 22; FIG. 9:4, 24; FIG. 10:4, 23; FIGs. 11-12: 4, 26, 27. The substantially elastic portion and the substantially rigid portion are of the same plastic. 2:1-2; 4:1-10; 8:23-30; 9:1-3, 23-31; 10:12-19; FIGs. 2a-4:4, 8; FIG. 5:4, 14; FIGs. 8a, 8b:4, 22; FIG. 9:4, 24; FIG. 10:4, 23; FIGs. 11-12: 4, 26, 27.

Claim 5 - The substantially elastic portion comprises one or more harness clips. 2:18-22; 6:19-23; 10:12-19; FIGs. 11a-12b:25.

Claim 7 - The substantially elastic portion comprises attachment elements for attaching at least one of electrical and electronic elements to the door module. 2:18-24; 6:19-23.

Claim 8 - The substantially elastic portion comprises attachment means for attaching noise reduction elements to at least one side of the door module. 2:24-31; 3:1-2; 8:15-16; 10:8-10; FIG. 5:14.

Claim 9 - The substantially elastic portion comprises a lip for contacting a door window. 8:12-21; 10:8-10; FIG. 5:14; FIG. 10:23.

Claim 10 - The long glass fibers of the long glass fiber enforced plastic material are staple glass fibers. 3:4-5.

Claim 11 - The glass fiber portion of the long glass fiber enforced plastic material is between 30 and 70%. 3:6-8.

Claim 12 - The glass fiber portion of the long glass fiber enforced plastic material is approximately 40%. 3:6-8.

Claim 13 - The glass fibers of the long glass fiber enforced plastic material have a length of approximately 20 mm, and a thickness of approximately 0.02 mm. 3:5-6.

Claim 23 - A vehicle door includes an inside panel with a surface cut-out recess. 1:30-31; 6:15-19, 27-30; 7:1-2; FIG. 1:1-3; FIGs. 2a-4:2, 12. A door module is also included in the vehicle door for covering the surface cut-out recess of the inside panel. 1:30-31; 2:1-4, 11-24; 3:10-16; 6:13-19; 27-30 FIG. 1:4; FIGs. 2a-4:2, 4, 12; FIGs. 5, 8a-10:4; FIGs. 11-12:4, 26. The door module includes a substantially rigid portion of long glass fiber reinforced plastic. 1:30-2:2; 3:4-8; 6:13-19; 9:23-24; 9:27-10:2; FIG. 1:1-4; FIGs. 2a-4:2, 4, 12; FIGs. 5, 8a-10:4; FIGs. 11-12:4, 26. The door module also includes a substantially elastic portion of plastic substantially

free of long glass fibers. 1:30-32; 2:1-9, 13-16, 20-31; 3:14-16, 26-30; 4:6-8; 6:30, 7:1-5, 13-27; 8:2-4, 6-14, 16-21; 9:19-21, 27-31; 10:1-19; FIG. 1:9; FIGs. 2a-2b:8, 9; FIGs. 3-5:8; FIGs. 8a-8b:22; FIG. 9:24; FIG. 10:23; FIGs. 11-12:27. The substantially rigid portion and the substantially elastic portion are formed in one piece. 1:30-32; 2:1-2; 4:1-10; 8:23-30; 9:1-3, 23-31; 10:12-19; FIGs. 2a-4:4, 8; FIG. 5:4, 14; FIGs. 8a, 8b:4, 22; FIG. 9:4, 24; FIG. 10:4, 23; FIGs. 11-12: 4, 26, 27. The substantially elastic portion and the substantially rigid portion are of the same plastic. 2:1-2; 4:1-10; 8:23-30; 9:1-3, 23-31; 10:12-19; FIGs. 2a-4:4, 8; FIG. 5:4, 14; FIGs. 8a, 8b:4, 22; FIG. 9:4, 24; FIG. 10:4, 23; FIGs. 11-12: 4, 26, 27.

Claim 28 - The substantially elastic portion comprises one or more wiring harness clips extending into the dry cell. 2:18-22; 6:19-23; 10:12-19; FIGs. 11a-12b:25.

Claim 30 - The vehicle door also includes at least one of an electrical and electronic element. The substantially elastic portion comprises attachment elements for attaching the at least one electrical and electronic element to the door module within the dry cell. 2:18-24; 6:19-23.

Claim 31 - The vehicle door also includes at least one noise reduction element. The substantially elastic portion comprises attachment means for attaching the at least one noise reduction element to at least one side of the door module. 2:24-31; 3:1-2; 8:15-16; 10:8-10; FIG. 5:14.

Claim 32 - A vehicle door includes an inside panel with a surface cut-out recess. 1:30-31; 6:15-19, 27-30; 7:1-2; FIG. 1:1-3; FIGs. 2a-4:2, 12. A door module is also included in the vehicle door for covering the surface cut-out recess of the inside panel. 1:30-31; 2:1-4, 11-24; 3:10-16; 6:13-19; 27-30 FIG. 1:4; FIGs. 2a-4:2, 4, 12; FIGs. 5, 8a-10:4; FIGs. 11-12:4, 26. The door module includes a substantially rigid portion of long glass fiber reinforced plastic. 1:30-2:2; 3:4-8; 6:13-19; 9:23-24; 9:27-10:2; FIG. 1:1-4; FIGs. 2a-4:2, 4, 12; FIGs. 5, 8a-10:4; FIGs. 11-12:4, 26. The door module also includes a substantially elastic portion of plastic substantially free of long glass fibers. 1:30-32; 2:1-9, 13-16, 20-31; 3:14-16, 26-30; 4:6-8; 6:30, 7:1-5, 13-27; 8:2-4, 6-14, 16-21; 9:19-21, 27-31; 10:1-19; FIG. 1:9; FIGs. 2a-2b:8, 9; FIGs. 3-5:8; FIGs. 8a-8b:22; FIG. 9:24; FIG. 10:23; FIGs. 11-12:27. The substantially rigid portion and the substantially elastic portion are formed in one piece. 1:30-32; 2:1-2; 4:1-10; 8:23-30; 9:1-3, 23-

31; 10:12-19; FIGs. 2a-4:4, 8; FIG. 5:4, 14; FIGs. 8a, 8b:4, 22; FIG. 9:4, 24; FIG. 10:4, 23; FIGs. 11-12: 4, 26, 27. An outside panel is also included in the vehicle door. 6:13-19. The vehicle door is divided into a wet cell, lying between the outside panel and the door module, and a dry cell, lying between the door module and an adjoining inside trim. 2:11-28; 6:16-21; 7:7-11; FIGs. 2a-2b:right and left sides. A door window is retractable into the wet cell. 2:30-31; 3:1-2; 8:12-21; FIG. 5:15. The substantially elastic portion comprises a lip for contacting the window when retracted into the wet cell. 2:30-31; 3:1-2; 8:12-21; FIG. 5:14.

Claim 33 - A door module for covering a surface cut-out recess in an inside panel of a vehicle door includes a single piece of plastic. 1:30-32; 2:1-2; 4:1-10; 8:23-30; 9:1-3, 23-31; 10:12-19; FIGs. 2a-4:4, 8; FIG. 5:4, 14; FIGs. 8a, 8b:4, 22; FIG. 9:4, 24; FIG. 10:4, 23; FIGs. 11-12: 4, 26, 27. 2:1-2; 4:1-10; 8:23-30; 9:1-3, 23-31; 10:12-19; FIGs. 2a-4:4, 8; FIG. 5:4, 14; FIGs. 8a, 8b:4, 22; FIG. 9:4, 24; FIG. 10:4, 23; FIGs. 11-12: 4, 26, 27. The single piece of plastic includes a substantially rigid portion with long glass fibers with the plastic as reinforcement. 1:30-2:2; 3:4-8; 6:13-19; 9:23-24; 9:27-10:2; FIG. 1:1-4; FIGs. 2a-4:2, 4, 12; FIGs. 5, 8a-10:4; FIGs. 11-12:4, 26. The single piece of plastic also includes a substantially elastic portion substantially free of long glass fibers. 1:30-32; 2:1-9, 13-16, 20-31; 3:14-16, 26-30; 4:6-8; 6:30, 7:1-5, 13-27; 8:2-4, 6-14, 16-21; 9:19-21, 27-31; 10:1-19; FIG. 1:9; FIGs. 2a-2b:8, 9; FIGs. 3-5:8; FIGs. 8a-8b:22; FIG. 9:24; FIG. 10:23; FIGs. 11-12:27.

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1-10, 14, and 23-33 stand rejected under 35 U.S.C. 102(e) as anticipated by U.S. Patent No. 6,422,640 to Whitehead et al. ("Whitehead"). Claims 11-13 are rejected under 35 U.S.C. 103(a) as obvious over Whitehead in view of U.S. Patent No. 6,305,129 to Eckhardt et al. ("Eckhardt").

7. ARGUMENT

A. Introduction

The application includes claims 1-14 and 23-33. In the Office action dated September 2, 2005, claims 1-10, 14, and 23-33 were rejected as anticipated by Whitehead, and claims 11-13

were rejected as obvious over Whitehead in view of Eckhardt. Reference below to this Office action is made in the form of "OA:x" where x is the page number.

The Board should find that claims 1-10, 14, and 23-33 are not anticipated by Whitehead, and that claims 11-13 are patentable over Whitehead in view of Eckhardt because many of the claim elements of these claims are not disclosed or suggested in the cited references or any motivated combination.

More specifically, each of the appealed claims relates to a door module comprising one piece of plastic with a substantially rigid portion and substantially elastic portion. The substantially rigid portion of plastic is of long glass fiber reinforced plastic. The substantially elastic portion is substantially free of long glass fibers. Neither Whitehead, Eckhardt, nor any combination of the two references teaches or suggests those limitations. Moreover, no motivation exists to combine Eckhardt into Whitehead in order to teach all of the elements of the appealed claims.

B. <u>Claims 1-10, 14, and 23-33 Are Not Anticipated By Whitehead</u>

<u>i. Claims 1-4, 6, and 14</u>

Whitehead does not disclose a door module with: 1) a substantially rigid portion with long glass fiber reinforced plastic; a substantially elastic portion substantially free of long glass fibers 2) formed in one piece with the substantially rigid portion; and 3) of the same plastic as the substantially rigid portion.

a. **<u>Whitehead does not disclose a door panel with "a substantially rigid portion of long glass fiber reinforced plastic."</u>**

Claim 1 recites, in part, "a substantially rigid portion of long glass fiber reinforced plastic."

The examiner contends that the door trim panel 34 in Whitehead is "formed of hard plastic, polypropylene, i.e. these plastics have long fibers/staple glass fibers, column 3, line 48." OA:2. The cited portion of Whitehead, however, states only that the panel is made of "polypropylene and formed by conventional injection molding processes as is known in the art." Although Whitehead discloses that the door trim panel 34 may be formed of hard plastic (Col. 3,

ln. 41) or polypropylene, it does not disclose that such hard plastic or polypropylene contains long glass fibers or staple glass fibers.

As there is no teaching in Whitehead that this hard plastic or polypropylene contains long glass fiber reinforcement, it appears that the examiner contends that such long glass fiber reinforcement is inherent in the terms "hard plastic" or "polypropylene." In order to rely on the theory of inherency, "the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic *necessarily* flows from the teachings of the applied prior art." *Ex parte Levy*, 17 U.S.P.Q.2d 1461, 1464 (Bd. Pat. App. & Inter. 1990) (emphasis in original) (quoted in MPEP §2112). To the contrary, inherency "may not be established by probabilities or possibilities. The mere fact that a certain thing *may* result from a given set of circumstances is not sufficient." *Continental Can Co. v. Monsanto Co.*, 948 F.2d 1264, 1268, 20 U.S.P.Q.2d 1746 (Fed. Cir. 1991) (quoting *In re Oelrich*, 666 F.2d 578, 581, 212 U.S.P.Q. 323, 326 (C.C.P.A. 1981)).

In the present case, rather than give a fact or reasoning that long glass fiber reinforced plastic *necessarily* flows from "hard plastic" or "polypropylene", the examiner merely asserted the conclusion "i.e. these plastics have long fibers/staple glass fibers" (OA:2) and stated without factual or technical support in the remarks that "it is well known in the art that hard or dense plastic (polypropylene) have long glass fibers and that less hard/dense, or elastic plastic (polypropylene) has short glass fibers or no fibers because of the desire to provide some flexibility to the plastic." OA:4. This argument falls far short of showing through "fact and/or technical reasoning" that "the allegedly inherent characteristic *necessarily* flows from the teachings of the applied prior art."[1]

To the contrary, "[p]lastics are designed with immense variation in properties such as heat tolerance, hardness, resiliency, and many others." *See*, "Plastic: Definition, Synonyms and Much More from Answers.com" ("Plastic"), page 5, submitted by Appellant in the Information Disclosure Statement of May 23, 2005. Harder forms of plastic may be manufactured through

[1] The examiner's statement on OA:2 that the door trim panel 34 of Whitehead is "formed of ...polypropylene, i.e. these plastics have long fibers/staple glass fibers" appears to indicate that polypropylene necessarily includes long glass fiber reinforcement. However, the examiner's assertion on OA:4 that those skilled in the art typically add glass fiber reinforcement to polypropylene would indicate that "polypropylene" on its own is not inherently reinforced by long glass fibers.

many different means, including use of various fillers, catalysts, and non-glass additives. *See*, e.g., Plastic, page 2.

Further, polypropylene is typically used in its hard form without any glass fiber additives. In fact, the soft form of polypropylene is rarer than its hard form, with the successful production of elastic polypropylene only announced in the 1990s. "Polypropylene is similar to its ancestor, polyethylene...but it is much more robust. It is used in everything from plastic bottles to carpets to plastic furniture, and is very heavily used in automobiles." Plastic, page 11. Polypropylene is commonly found in rigid products, such as bottle caps (Plastic, page 11), food containers (page 15) and appliances (page 15), and its chemical composition (which does not include any glass fiber reinforcement) can be seen in Plastic, page 11.

Also in the Information Disclosure Statement filed on May 23, 2005 was a document entitled "Wikipedia information about Glass-reinforced plastic; licensed under the GNU Free Documentation License; http://www.answers.com." In this document, Glass-reinforced plastic is defined as a "*composite* material made of a plastic reinforced by fine fibers made of glass" (emphasis added).

As neither "hard plastic" nor polypropylene necessarily requires long glass fiber reinforcement, Appellant respectfully submits that disclosure of "hard plastic" and "polypropylene" in Whitehead does not explicitly or inherently disclose a substantially rigid portion of long glass fiber reinforced plastic, as claimed in claim 1.

Despite this application undergoing prosecution since 2001, no reference has been cited that explicitly discloses any support for the contention that all "hard plastics" and "polypropylene" necessarily include long glass fiber reinforcement. As Whitehead does not disclose this limitation of claim 1, Appellant submits that claim 1 is not anticipated by Whitehead.

b. Whitehead does not disclose a substantially rigid portion of long glass fiber reinforced plastic formed in one piece and of the same plastic as the substantially elastic portion.

Claim 1 further recites, in part, "a substantially elastic portion of plastic substantially free of long glass fibers and formed in one piece with the substantially rigid portion, wherein the

substantially rigid portion and the substantially elastic portion are of the same plastic." Appellant further submits that Whitehead does not describe a substantially rigid portion of long glass fiber reinforced plastic formed in one piece and of the same plastic as the substantially elastic portion.

The examiner maintains that the carrier 20 corresponds to the substantially elastic portion in Appellant's claim 1. Appellant submits, however, that the carrier 20 is not formed in one piece with any element that could be considered long glass fiber reinforced plastic. In fact, Whitehead is very specific about how the carrier 20 is formed out of expanded polypropylene, including fusing beads of plastics together by mechanical and thermoplastic bonding caused by steam. Col. 4, lns. 31-35. Nowhere in this discussion of forming the carrier 20 is forming it in one piece with a portion with long glass fiber reinforcement mentioned. Moreover, there is no disclosure in Whitehead of how a substantially rigid portion of long glass fiber reinforced plastic could be formed in one piece and of the same plastic as an elastic portion created by fusing beads of plastics. Because Whitehead does not describe *any* element having long glass fiber reinforced plastic, nor any substantially elastic portion substantially free of long glass fibers formed in one piece and with the same plastic as the long glass fiber reinforced plastic, Appellant respectfully submits that claim 1 is not anticipated by Whitehead.

c. <u>Claims 2-4, 6, and 14</u>

As claims 2-4, 6, and 14 depend from claim 1, and the examiner has failed to make a *prima facie* showing that the cited reference discloses any of the aspects of claim 1 disclosed above, the examiner has also failed to make a prima facie showing that the cited references disclose any of the same aspects of each of claims 2-4, 6, and 14.

ii. <u>Claim 5</u>

Claim 5 recites that "the substantially elastic portion comprises <u>one or more wiring harness clips</u>." The examiner indicated that the carrier 20 of Whitehead corresponds to the "substantially elastic portion" of Appellant's claims. However, the examiner has not pointed out and the Appellant cannot find any disclosure in Whitehead of the carrier 20 comprising one or more wiring harness clips. As this limitation is not found in Whitehead, Appellant respectfully submits that claim 5 is not anticipated by Whitehead. Appellant further submits that claim 5 is

dependent on claim 1, and is therefore also patentable for the reasons discussed in reference to claim 1.

iii. Claim 7

Claim 7 recites that "the substantially elastic portion comprises attachment elements for attaching at least one of electrical and electronic elements to the door module." The examiner indicated that the carrier 20 of Whitehead corresponds to the "substantially elastic portion" of Appellant's claims. However, the examiner has not pointed out and the Appellant cannot find any disclosure in Whitehead of the carrier 20 comprising attachment elements for attaching electrical and/or electronic elements to the door module. As this limitation is not found in Whitehead, Appellant respectfully submits that claim 7 is not anticipated by Whitehead. Appellant further submits that claim 7 is dependent on claim 1, and is therefore also patentable for the reasons discussed in reference to claim 1.

iv. Claim 8

Claim 8 recites that "the substantially elastic portion comprises attachment means for attaching noise reduction elements to at least one side of the door module." The examiner indicated that the carrier 20 of Whitehead corresponds to the "substantially elastic portion" of Appellant's claims, and that "the hollow portion 32 and the sealing that surrounds the hollow portion or the extension clip rod attachments seen in Figure 2" of Whitehead corresponds to the attachment means. However, the examiner has not pointed out and the Appellant cannot find any disclosure in Whitehead of any of these elements serving as attachment means for attaching noise reduction elements. As this limitation is not found in Whitehead, Appellant respectfully submits that claim 8 is not anticipated by Whitehead. Appellant further submits that claim 8 is dependent on claim 1, and is therefore also patentable for the reasons discussed in reference to claim 1.

v. Claim 9

Claim 9 recites that "the substantially elastic portion comprises a lip for contacting a door window." The examiner indicated that the carrier 20 of Whitehead corresponds to the "substantially elastic portion" of Appellant's claims, and that the projections 28 or the sealing member 142 correspond to the lip for contacting a door window. However, the examiner has not

pointed out and the Appellant cannot find any disclosure in Whitehead of either of these elements contacting a door window. As this limitation is not found in Whitehead, Appellant respectfully submits that claim 9 is not anticipated by Whitehead. Appellant further submits that claim 9 is dependent on claim 1, and is therefore also patentable for the reasons discussed in reference to claim 1.

vi. Claim 10

Claim 10 recites that "the long glass fibers of the long glass fiber enforce plastic material are staple glass fibers." As discussed above, the examiner indicated that, because the door panel 34 is described in Whitehead as being made of "hard plastic," the door panel necessarily includes staple glass fibers. As discussed above in relation to claim 1, however, hard plastic may be made in any number of ways, and need not be reinforced by staple glass fibers to be hard. In fact, as discussed above, the predominant form of polypropylene is a hard form. As Whitehead does not disclose this limitation, Appellant submits that claim 10 is not anticipated by Whitehead. Appellant further submits that claim 10 is dependent on claim 1, and is therefore also patentable for the reasons discussed in reference to claim 1.

vii. Claims 23-27, and 29

Claim 23 is an independent claim directed to a vehicle door. Claims 24-31 depend on claim 23. Claim 23 recites, in part, that the vehicle door comprises a door module including "a substantially rigid portion of long glass fiber reinforced plastic," "substantially elastic portion of plastic substantially free of long glass fibers and formed in one piece with the substantially rigid portion," and "the substantially rigid portion and the substantially elastic portion are of the same plastic."

Claim 23 was rejected in the same paragraph and for the same reasons as claim 1. OA:2. Appellant submits that Whitehead does not disclose a vehicle door having a door module with: 1) a substantially rigid portion with long glass fiber reinforced plastic; a substantially elastic portion substantially free of long glass fibers 2) formed in one piece with the substantially rigid portion; and 3) of the same plastic as the substantially rigid portion, as discussed above in reference to claim 1. Accordingly, the examiner has not made a *prima facie* showing that Whitehead anticipates claim 23.

a. **Claims 24-27 and 29**

As claims 24-27 and 29 depend from claim 23, and the examiner has failed to make a *prima facie* showing that the cited reference discloses any of the aspects of claim 23 discussed above, the examiner has also failed to make a *prima facie* showing that the cited references disclose any of the same aspects of each of claims 24-27 and 29.

viii. Claim 28

Claim 28 recites that "the substantially elastic portion comprises one or more wiring harness clips extending into the dry cell." The examiner indicated that the carrier 20 of Whitehead corresponds to the "substantially elastic portion" of Appellant's claims. However, the examiner has not pointed out and the Appellant cannot find any disclosure in Whitehead of the carrier 20 comprising one or more wiring harness clips, or wiring harness clips extending in to a dry cell. As this limitation is not found in Whitehead, Appellant respectfully submits that claim 28 is not anticipated by Whitehead. Appellant further submits that claim 28 is dependent on claim 23, and is therefore also patentable for the reasons discussed in reference to claim 23.

ix. Claim 30

Claim 30 recites "at least one of an electrical and electronic element, wherein the substantially elastic portion comprises attachment elements for attaching at least one of electrical and electronic element to the door module within the dry cell." The examiner indicated that the carrier 20 of Whitehead corresponds to the "substantially elastic portion" of Appellant's claims. However, the examiner has not pointed out and the Appellant cannot find any disclosure in Whitehead of electrical and/or electronic elements in the vehicle door, nor that the carrier 20 comprises attachment elements for attaching the electrical and/or electronic elements to the door module within the dry cell. As these limitations are not found in Whitehead, Appellant respectfully submits that claim 30 is not anticipated by Whitehead. Appellant further submits that claim 30 is dependent on claim 23, and is therefore also patentable for the reasons discussed in reference to claim 23.

x. Claim 31

Claim 31 recites "at least one noise reduction element, wherein the substantially elastic portion comprises attachment means for attaching the at least one noise reduction element to at

least one side of the door module." The examiner indicated that the carrier 20 of Whitehead corresponds to the "substantially elastic portion" of Appellant's claims, and that "the hollow portion 32 and the sealing that surrounds the hollow portion or the extension clip rod attachments seen in Figure 2" of Whitehead corresponds to the attachment means. However, the examiner has not pointed out and the Appellant cannot find any disclosure in Whitehead of at least one noise reduction element or of any of the cited elements attaching a noise reduction element. As this limitation is not found in Whitehead, Appellant respectfully submits that claim 31 is not anticipated by Whitehead. Appellant further submits that claim 31 is dependent on claim 23, and is therefore also patentable for the reasons discussed in reference to claim 23.

xi. Claim 32

Claim 32 is an independent claim directed to a vehicle door. No claims depend from claim 32. Claim 32 recites, in part, "the door module includes a <u>substantially rigid portion of long glass fiber reinforced plastic</u> and a <u>substantially elastic portion of plastic substantially free of long glass fibers and formed in one piece with the substantially rigid portion</u>." This limitation is similar to the limitations discussed above in reference to claim 1.

Claim 32 was rejected in the same paragraph and for the same reasons as claim 1. OA:2. Appellant submits that Whitehead does not disclose a vehicle door having a door module with: 1) a substantially rigid portion with long glass fiber reinforced plastic; and a substantially elastic portion substantially free of long glass fibers 2) formed in one piece with the substantially rigid portion, as discussed above in reference to claim 1. Accordingly, the examiner has not made a *prima facie* showing that Whitehead anticipates claim 32.

Claim 32 additionally recites, in part, "a <u>door window</u> retractable into the wet cell, wherein the substantially elastic portion comprises a <u>lip for contacting the window</u> when retracted into the wet cell of the vehicle door." The examiner indicated that the carrier 20 of Whitehead corresponds to the "substantially elastic portion" of Appellant's claims, and that the projections 28 or the sealing member 142 correspond to the lip for contacting a door window. However, the examiner has not pointed out and the Appellant cannot find any disclosure in Whitehead of a door window or either of these elements contacting a door window. As these

limitations are not found in Whitehead, Appellant respectfully submits that claim 32 is not anticipated by Whitehead.

xii. Claim 33

Claim 33 is an independent claim directed to a door module. No claims depend from claim 33. Claim 33 recites, in part, "the door module comprises: a single piece of plastic having a substantially rigid portion and a substantially elastic portion; the substantially rigid portion having long glass fibers within the plastic as reinforcement, and the substantially elastic portion substantially free of long glass fibers."

Claim 33 was rejected in the same paragraph and for the same reasons as claim 1. OA:2. Appellant submits that Whitehead does not disclose a vehicle door having a door module with: 1) a single piece of plastic having 2) a substantially rigid portion with long glass fibers within the plastic as reinforcement and 3) a substantially elastic portion substantially free of long glass fibers. Accordingly, the examiner has not made a *prima facie* showing that Whitehead anticipates claim 33.

C. Claims 11-13 Are Patentable Over Whitehead In View of Eckhardt

i. Claim 11

Claim 11 is dependent on claim 1 and is patentable for the reasons discussed in relation to claim 1. The examiner rejected claim 11 under 35 U.S.C. 103(a) as obvious over Whitehead in view of Eckhardt et al. OA:3. Appellant respectfully submits that Eckhardt fails to cure Whitehead's deficiencies. Like Whitehead, Eckhardt teaches that the door trim panel 20 should be made of plastic. Col. 3, lns. 7-17. The examiner points out that a separate and unrelated element (drum 30) that is a "part of the window lift mechanism" is made of glass reinforced plastic. Col. 3, lns. 26-27. Although Eckhardt states that the drum can be made of "NYLON(R) including glass fibers," Eckhardt does not teach that a portion of the door trim panel should be modified to include long glass fiber reinforced plastic, and be formed in one piece and of the same plastic as the carrier 20 of Whitehead.

Instead, Eckhardt states that the door trim panel should be made of plastic (not specifying glass reinforcement) and that a glass-reinforced NYLON drum is formed as a completely separate element. It is unclear why one of ordinary skill in the art would modify the door

module in Whitehead to include a material in a completely separate and unrelated element in Eckhardt (i.e., a drum), particularly since Eckhardt itself did not disclose forming a door trim panel with glass fiber reinforcement.

Claim 11 also recites that "the glass fiber portion of the long glass fiber enforced plastic material is between 30 and 70%." As neither Eckhardt, Whitehead, nor any motivated combination of the two references, teaches or suggests a door module with a substantially rigid portion of long glass fiber reinforced plastic as claimed in claim 1, neither reference nor any motivated combination teaches or suggests the glass fiber portion being between 30 and 70% of the long glass fiber enforced plastic material. Appellant therefore submits that claim 11 is not obvious over Whitehead in view of Eckhardt.

ii. <u>Claim 12</u>

The examiner rejected claim 12 under 35 U.S.C. 103(a) as obvious over Whitehead in view of Eckhardt et al. OA:3. Claim 12 is dependent on claims 1 and 11, and is patentable for the reasons discussed in relation to claims 1 and 11, above.

Claim 12 also recites that "the glass fiber portion of the long glass fiber enforced plastic material is approximately 40%." As neither Eckhardt, Whitehead, nor any motivated combination of the two references, teaches or suggests the substantially rigid portion of long glass fiber reinforced plastic as claimed in claim 1, neither of these references nor any motivated combination teach or suggest the glass fiber portion being 40% of the long glass fiber enforced plastic material. Appellant therefore submits that claim 12 is not obvious over Whitehead in view of Eckhardt.

iii. <u>Claim 13</u>

The examiner rejected claim 13 under 35 U.S.C. 103(a) as obvious over Whitehead in view of Eckhardt et al. OA:3. Claim 13 is dependent on claim 1, and is patentable for the reasons discussed in relation to claim 1, above.

Claim 13 also recites that "the glass fibers of the long glass fiber enforced plastic material have a length of approximately 20 mm, and a thickness of approximately 0.02mm." As neither Eckhardt, Whitehead, nor any motivated combination of the two references, teaches or suggests the substantially rigid portion of long glass fiber reinforced plastic as claimed in claim 1, neither

of these references nor their combination teach or suggest the glass fibers of the long glass fiber reinforced plastic having the claimed length and thickness. Appellant therefore submits that claim 13 is not obvious over Whitehead in view of Eckhardt.

D. Conclusion

For the reasons discussed above, Appellant respectfully submits that the Board should find that claims 1-10, 14, and 23-33 are not anticipated by Whitehead, and that claims 11-13 are patentable over Whitehead in view of Eckhardt because many of the claim elements of these claims are not disclosed or suggested in the cited references or any motivated combination.

Respectfully submitted,

CHRISTIE, PARKER & HALE, LLP

By ______________________

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626/795-9900

8. CLAIM APPENDIX

1. A door module for covering a surface cut-out recess in an inside panel of a vehicle door, the door module comprising:

a substantially rigid portion of long glass fiber reinforced plastic; and

a substantially elastic portion of plastic substantially free of long glass fibers and formed in one piece with the substantially rigid portion,

wherein the substantially rigid portion and the substantially elastic portion are of the same plastic.

2. The door module of claim 1, wherein the substantially elastic portion comprises a lip seal for extending along an outer rim area of the door module.

3. The door module of claim 2, wherein the substantially elastic portion comprises two lip seals for extending in parallel along the outer rim area of the door module.

4. The door module of claim 1, wherein the substantially elastic portion comprises a drip ledge.

5. The door module of claim 1, wherein the substantially elastic portion comprises one or more wiring harness clips.

6. The door module of claim 1, wherein the substantially elastic portion comprises attachment elements for attaching the door module to the door.

7. The door module of claim 1, wherein the substantially elastic portion comprises attachment elements for attaching at least one of electrical and electronic elements to the door module.

8. The door module of claim 1, wherein the substantially elastic portion comprises attachment means for attaching noise reduction elements to at least one side of the door module.

9. The door module of claim 1, wherein the substantially elastic portion comprises a lip for contacting a door window.

10. The door module of claim 1, wherein the long glass fibers of the long glass fiber enforced plastic material are staple glass fibers.

11. The door module of claim 1, wherein the glass fiber portion of the long glass fiber enforced plastic material is between 30 and 70%.

12. The door module of claim 11, wherein the glass fiber portion of the long glass fiber enforced plastic material is approximately 40%.

13. The door module of claim 1, wherein the glass fibers of the long glass fiber enforced plastic material have a length of approximately 20 mm, and a thickness of approximately 0.02 mm.

14. The door module of claim 1, wherein the plastic material is polypropylene.

23. A vehicle door comprising:

an inside panel with a surface cut-out recess; and

a door module for covering the surface cut-out recess of the inside panel,

wherein the door module includes a substantially rigid portion of long glass fiber reinforced plastic and a substantially elastic portion of plastic substantially free of long glass fibers and formed in one piece with the substantially rigid portion,

wherein the substantially rigid portion and the substantially elastic portion are of the same plastic.

24. The vehicle door of claim 23, further comprising an outside panel, wherein the door is divided into a wet cell lying between the outside panel and the door module and a dry cell lying between the door module and an adjoining inside trim.

25. The vehicle door of claim 23, wherein the substantially elastic portion comprises a lip seal extending along an outer rim area of the door module, for sealing a connection between the door module and the inside panel.

26. The vehicle door of claim 23, wherein the substantially elastic portion comprises two lip seals extending in parallel along an outer rim area of the door module, for sealing the connection between the door module and the inside panel.

27. The vehicle door of claim 24, wherein the substantially elastic portion comprises a drip ledge extending into the wet cell along a lower area of the door module when installed in the vehicle door, for repelling water from a connection between the door module and the inside panel of the vehicle door.

28. The vehicle door of claim 24, wherein the substantially elastic portion comprises one or more wiring harness clips extending into the dry cell.

29. The vehicle door of claim 23, wherein the substantially elastic portion comprises attachment elements for attaching an outer edge of the surface cut-out recess to the door module.

30. The vehicle door of claim 24, further comprising at least one of an electrical and electronic element, wherein the substantially elastic portion comprises attachment elements for attaching the at least one electrical and electronic element to the door module within the dry cell.

31. The vehicle door of claim 23, further comprising at least one noise reduction element, wherein the substantially elastic portion comprises attachment means for attaching the at least one noise reduction element to at least one side of the door module.

32. A vehicle door comprising:

an inside panel with a surface cut-out recess;

a door module for covering the surface cut-out recess of the inside panel, wherein the door module includes a substantially rigid portion of long glass fiber reinforced plastic and a substantially elastic portion of plastic substantially free of long glass fibers and formed in one piece with the substantially rigid portion;

an outside panel, wherein the door is divided into a wet cell lying between the outside panel and the door module and a dry cell lying between the door module and an adjoining inside trim; and

a door window retractable into the wet cell, wherein the substantially elastic portion comprises a lip for contacting the window when retracted into the wet cell of the vehicle door.

33. A door module for covering a surface cut-out recess in an inside panel of a vehicle door, the door module comprising:

a single piece of plastic having a substantially rigid portion and a substantially elastic portion;

the substantially rigid portion having long glass fibers within the plastic as reinforcement, and

the substantially elastic portion substantially free of long glass fibers.

9. EVIDENCE APPENDIX

1. Wikipedia information about Glass-reinforced plastic; licensed under the GNU Free Documentation License; http://www.answers.com; submitted by Applicant in Information Disclosure Statement filed on May 23, 2005.

2. Plastic: Definition, Synonyms and Much More from Answers.com; http://www.answers.com; submitted by Applicant in Information Disclosure Statement filed on May 23, 2005.

10. RELATED PROCEEDING APPENDIX

None

Glass-reinforced plastic

Wikipedia
Glass-reinforced plastic

This article or section should be merged with Fiberglass

Glass-reinforced plastic (GRP), is a composite material made of a plastic reinforced by fine fibers made of glass. The plastic is most often polyester, but other plastics, like epoxy (GRE), are also sometimes used.

GRP/GRE is a versatile material with many uses. Its first main application was for building of boats, where it gained acceptance in the 1950s, and now plays a dominant role. But its use has broadened over the years, and it is used extensively within the automotive and sport equipment sectors. GRE is also used to make pipes for drinking water, sewers, chemicals, and so on. The term "fiberglass" is often used, rather imprecisely, for GRP.

Mentioned In
glass reinforced plastic is mentioned in the following topics:

GRP
Methyl ethyl ketone peroxide
Porsche 934
Lotus Elite
thermosetting plastic
Jensen Interceptor
Hunt class minesweeper (1978)
Dry Deck Shelter
Optimist (dinghy)
composite material
More>

plastic

Dictionary
plas·tic (plăs'tĭk)
adj.

1. Capable of being shaped or formed: *plastic material such as clay.* See synonyms at malleable.
2. Relating to or dealing with shaping or modeling: *the plastic art of sculpture.*
3. Having the qualities of sculpture; well-formed: *"the astonishing plastic beauty of the chorus girls"* (Frank Harris).
4. Giving form or shape to a substance: *the plastic forces that create and wear down a mountain range.*
5. Easily influenced; impressionable.
6. Made of a plastic or plastics: *a plastic garden hose.*
7. *Physics.* Capable of undergoing continuous deformation without rupture or relaxation.
8. *Biology.* Capable of building tissue; formative.
9. Marked by artificiality or superficiality; synthetic: *a plastic world of fad, hype, and sensation.*
10. *Informal.* Of or obtained by means of credit cards: *plastic money.*

n.

1. Any of various organic compounds produced by polymerization, capable of being molded, extruded, cast into various shapes and films, or drawn into filaments used as textile fibers.
2. Objects made of plastic.
3. *Informal.* A credit card or credit cards: *would accept cash or plastic in payment.*

[Latin plasticus, from Greek plastikos, from plastos, molded, from plassein, to mold.]

plas'ti·cal·ly *adv.*
plas·tic'i·ty (plăs-tĭs'ĭ-tē) *n.*

Thesaurus
plastic

adjective

1. Capable of being shaped, bent, or drawn out, as by hammering or pressure: ductile, flexible, flexile, flexuous, malleable, moldable, pliable, pliant, supple, workable. *See* flexible/rigid.
2. Changing easily, as in expression: changeable, fluid, mobile. *See* change/persist.
3. Easily altered or influenced: ductile, elastic, flexible, flexile, impressionable, malleable, pliable, pliant, suggestible, supple. *See* flexible/rigid.
4. Capable of withstanding stress without injury: elastic, flexible, flexile, resilient, springy, supple. *See* flexible/rigid.
5. Marked by unnaturalness, pretension, and often a slavish love of fads: artificial, factitious, synthetic, unnatural. *See* honest/dishonest.

Encyclopedia
plastic, any organic material with the ability to flow into a desired shape when heat and pressure are applied to it and to retain the shape when they are withdrawn.

Composition and Types of Plastic

A plastic is made up principally of a binder together with plasticizers, fillers, pigments, and other additives. The binder gives a plastic its main characteristics and usually its name. Thus, *polyvinyl chloride* is both the name of a binder and the name of a plastic into which it is made. Binders may be natural materials, e.g., cellulose derivatives, casein, or milk protein, but are more commonly synthetic resins. In either case, the binder materials consist of very long chainlike molecules called polymers. Cellulose derivatives are made from cellulose, a naturally occurring polymer; casein is also a naturally occurring polymer. Synthetic resins are polymerized, or built up, from small simple molecules called monomers. Plasticizers are added to a binder to increase flexibility and toughness. Fillers are added to improve particular properties, e.g., hardness or resistance to shock. Pigments are used to impart various colors. Virtually any desired color or shape and many combinations of the properties of hardness, durability, elasticity, and resistance to heat, cold, and acid can be obtained in a plastic.

There are two basic types of plastic: thermosetting, which cannot be resoftened after being subjected to heat and pressure; and thermoplastic, which can be repeatedly softened and remolded by heat and pressure. When heat and pressure are applied to a

thermoplastic binder, the chainlike polymers slide past each other, giving the material "plasticity." However, when heat and pressure are initially applied to a thermosetting binder, the molecular chains become cross-linked, thus preventing any slippage if heat and pressure are reapplied.

See epoxy resins; polyacrylics; polycarbonates; polyethylene; polyolefins; polypropylene; polystyrene; polyurethanes; polyvinyl chloride; vinyl plastics.

Molding of Plastic

Plastics are available in the form of bars, tubes, sheets, coils, and blocks, and these can be fabricated to specification. However, plastic articles are commonly manufactured from plastic powders in which desired shapes are fashioned by compression, transfer, injection, or extrusion molding. In compression molding, materials are generally placed immediately in mold cavities, where the application of heat and pressure makes them first plastic, then hard. The transfer method, in which the compound is plasticized by outside heating and then poured into a mold to harden, is used for designs with intricate shapes and great variations in wall thickness. Injection-molding machinery dissolves the plastic powder in a heating chamber and by plunger action forces it into cold molds, where the product sets. The operations take place at rigidly controlled temperatures and intervals. Extrusion molding employs a heating cylinder, pressure, and an extrusion die through which the molten plastic is sent and from which it exits in continuous form to be cut in lengths or coiled.

Environmental Considerations

Plastics are so durable that they will not rot or decay as do natural products such as those made of wood. As a result great amounts of discarded plastic products accumulate in the environment as waste. It has been suggested that plastics could be made to decompose slowly when exposed to sunlight by adding certain chemicals to them. Plastics present the additional problem of being difficult to burn. When placed in an incinerator, they tend to melt quickly and flow downward, clogging the incinerator's grate. They also emit harmful fumes; e.g., burning polyvinyl chloride gives off hydrogen chloride gas.

Development of Plastics

The first important plastic, celluloid, was discovered (c.1869) by the American inventor John W. Hyatt and manufactured by him in 1872; it is a mixture of cellulose nitrate, camphor, and alcohol and is thermoplastic. However, plastics did not come into modern industrial use until after the production (1909) of Bakelite by the American chemist L. H. Baekeland. Bakelite, made by the polymerization of phenol and formaldehyde, is thermosetting. New uses for plastics are continually being discovered. Following World War II optical lenses, artificial eyes, and dentures of acrylic plastics, splints that X rays may pierce, nylon fibers, machine gears, fabric coatings, wall surfacing, and plastic lamination were developed. More recently a hydrophilic, or water-attracting, plastic suitable for use in non-irritating contact lenses has been developed. Among the trade names by which many plastic products are widely known are Plexiglas, Lucite, Polaroid, Cellophane, Vinylite, and Koroseal. Plastics reinforced with fiberglass are used for boats, automobile bodies, furniture, and building panels.

Bibliography

See L. K. Arnold, *Introduction to Plastics* (1968); J. H. DuBois, *Plastics History, U.S.A.* (1972); H. D. Junge, *Dictionary of Plastics Technology* (1987); A. W. Birley et al.,

Plastics Materials: Properties and Applications (1988).

HOUGHTON MIFFLIN COMPANY

Medical

plas·tic (plăs'tĭk)

adj.

1. Capable of being shaped or formed.
2. Easily influenced; impressionable.
3. Capable of building tissue; formative.

n.

Any of various organic compounds produced by polymerization, capable of being molded, extruded, cast into various shapes and films, or drawn into filaments used as textile fibers.

plas·tic'i·ty (plăs-tĭs'ĭ-tē) *n.*

WordNet

Note: click on a word meaning below to see its connections and related words.

The *noun* plastic has one meaning:

Meaning #1: generic name for certain synthetic or semisynthetic materials that can be molded or extruded into objects or films or filaments or used for making e.g. coatings and adhesives

---

The *adjective* plastic has 3 meanings:

Meaning #1: used of the imagination

Meaning #2: capable of being molded or modeled (especially of earth or clay or other soft material)
Synonyms: fictile, moldable

Meaning #3: capable of being influenced or formed
Synonym: pliant

Wikipedia

plastic

The term "**plastics**" covers a range of synthetic or semi-synthetic polymerization products. They are composed of organic condensation or addition polymers and may (often) contain other substances to improve performance or economics. There are few natural polymers generally considered to be "plastics". Plastics can be formed into

objects or films or fibers. Their name is derived from the fact that many are malleable, having the property of plasticity. Plastics are designed with immense variation in properties such as heat tolerance, hardness, resiliency and many others. Combined with this adaptability, the general uniformity of composition and light weight of plastics ensures their use in almost all industrial segments.

"**Plastic**" may also refer to any material characterized by deformation or failure under shear stress- see Plasticity (physics) and ductile.

Plastics can be classified in many ways but most commonly by their polymer back-bone (vinyl{chloride}, polyethylene, acrylic, silicone, urethane, etc.). Other classifications are not uncommon - e.g. thermoplastic or thermoset; elastomer or engineering plastic; addition or condensation; or by their Tg (Glass transition temperature, read "T sub g" or "Tee-gee" - its the polymer equivalent of a melting point - although some polymers have both a melting point and a Tg!).

Plastics are polymers: long-chains of atoms bonded to one another. These chains are made up of many repeating molecular units, or "monomers". The vast majority of plastics are composed of polymers of carbon alone or with oxygen, nitrogen, chlorine or sulfur in the back-bone. (Some of commercial interest are silicon based.) The back-bone is that part of the chain on the main "path" linking the multitude of monomer units together. To customize the properties of a plastic different molecular groups "hang" from the back-bone (usually they are "hung" as part of the monomers before linking monomers together to form the polymer chain). This customization by pendant groups has allowed plastics to become such an indispensable part of 21st Century life by fine-tuning the properties of the polymer.

The development of plastics has come from the use of natural materials (e.g. chewing gum, shellac) to the use of chemically modified natural materials (e.g. natural rubber, nitrocellulose) and finally to completely man-made molecules (e.g. epoxy, polyvinyl chloride, polyethylene).

Natural polymers

People have been using artificial organic polymers for centuries in the form of waxes and shellacs. A plant polymer named "cellulose" provides the structural strength for natural fibers and ropes, and by the early 19th century natural rubber, tapped from rubber trees, was in widespread use.

Eventually, inventors learned to improve the properties of natural polymers. Natural rubber was sensitive to temperature, becoming sticky and smelly in hot weather and brittle in cold weather. In 1834, two inventors, Friedrich Ludersdorf of Germany and Nathaniel Hayward of the US, independently discovered that adding sulfur to raw rubber helped prevent the material from becoming sticky.

In 1839, the American inventor Charles Goodyear was experimenting with the sulfur treatment of natural rubber when, according to legend, he dropped a piece of sulfur-treated rubber on a stove. The rubber seemed to have improved properties, and Goodyear followed up with further experiments, and developed a process known as "vulcanization" that involved cooking the rubber with sulfur. Compared to untreated natural rubber, Goodyear's "vulcanized rubber" was stronger, more resistant to abrasion, more elastic, much less sensitive to temperature, impermeable to gases, and highly resistant to chemicals and electric current.

Vulcanization remains an important industrial process for the manufacture of rubber in both natural and artificial forms. Natural rubber is composed of an organic polymer

named "isoprene". Vulcanization creates sulfur bonds that link separate isoprene polymers together, improving the material's structural integrity and its other properties.

Cellulose based plastics: celluloid and rayon

All Goodyear had done with vulcanization was improve the properties of a natural polymer. The next logical step was to use a natural polymer, cellulose, as the basis for a new material.

Inventors were particularly interested in developing synthetic substitutes for those natural materials that were expensive and in short supply, since that meant a profitable market to exploit. Ivory was a particularly attractive target for a synthetic replacement.

An Englishman from Birmingham, named Alexander Parkes developed a "synthetic ivory" named "pyroxlin", which he marketed under the trade name "Parkesine", and which won a bronze medal at the 1862 World's fair in London. Parkesine was made from cellulose treated with nitric acid and a solvent. The output of the process hardened into a hard, ivory-like material that could be molded when heated.

However, Parkes was not able to scale up the process to an industrial level, and products made from Parkesine quickly warped and cracked after a short period of use. An American printer and amateur inventor named John Wesley Hyatt took up where Parkes left off. Parkes had failed for lack of a proper softener, but Hyatt discovered that camphor would do the job very nicely.

Hyatt was something of an industrial genius who understood what could be done with such a shapeable, or "plastic", material, and proceeded to design much of the basic industrial machinery needed to produce good-quality plastic materials in quantity. Since cellulose was the main constituent used in the synthesis of his new material, Hyatt named it "celluloid". It was introduced in 1863.

One of the first products were dental pieces, and sets of false teeth built around celluloid proved cheaper than existing rubber dentures. However, celluloid dentures tended to soften when hot, making tea drinking tricky, and the camphor taste tended to be difficult to suppress.

Celluloid's real breakthrough products were waterproof shirt collars, cuffs, and the false shirt fronts known as "dickies", whose unmanageable nature later became a stock joke in silent-movie comedies. They didn't wilt and didn't stain easily, and Hyatt sold them by trainloads. Corsets made with celluloid stays also proved popular, since perspiration didn't rust the stays, as it would if they had been made of metal.

Celluloid proved extremely versatile in its field of application, providing a cheap and attractive replacement for ivory, tortoiseshell, and bone, and traditional products that had used these materials were much easier to fabricate with plastics. Some of the items made with cellulose in the 19th century were beautifully designed and implemented. For example, celluloid combs made to tie up the long tresses of hair fashionable at the time are now jewel-like museum pieces. Such pretty trinkets were no longer only for the rich.

Celluloid could also be used in entirely new applications. Hyatt figured out how to fabricate the material in a strip format for movie film. By the year 1900, movie film was a major market for celluloid.

However, celluloid still tended to yellow and crack over time, and it had another, more dangerous defect: it burned very easily and spectacularly, unsurprising given that

mixtures of nitric acid and cellulose are also used to synthesize smokeless powder.

Ping-pong balls, one of the few products still made with celluloid, sizzle and burn if set on fire, and Hyatt liked to tell stories about celluloid billiard balls exploding when struck very hard. These stories might have had a basis in fact, since the billiard balls were often celluloid covered with paints based on another, even more flammable, nitrocellulose product known as "collodion". If the balls had been imperfectly manufactured, the paints might have acted as primer to set the rest of the ball off with a bang.

Cellulose was also used to produce cloth. While the men who developed celluloid were interested in replacing ivory, those who developed the new fibers were interested in replacing another expensive material, silk.

In 1884, a French chemist, the Comte de Chardonnay, introduced a cellulose-based fabric that became known as "Chardonnay silk". It was an attractive cloth, but like celluloid it was very flammable, a property completely unacceptable in clothing. After some ghastly accidents, Chardonnay silk was taken off the market.

In 1894, three British inventors, Charles Cross, Edward Bevan, and Clayton Beadle, patented a new "artificial silk" or "art silk" that was much safer. The three men sold the rights for the new fabric to the French Courtald company, a major manufacturer of silk, which put it into production in 1905, using cellulose from wood pulp as the "feedstock" material.

Art silk became well known under the trade name "rayon", and was produced in great quantities through the 1930s, when it was supplanted by better artificial fabrics. It still remains in production today, often in blends with other natural and artificial fibers. It is cheap and feels smooth on the skin, though it is weak when wet and creases easily. It could also be produced in a transparent sheet form known as "cellophane".

Bakelite (phenolic)

The limitations of celluloid led to the next major advance, known as "phenolic" or "phenol-formaldehyde" plastics. A chemist named Leo Hendrik Baekeland, a Belgian-born American living in New York state, was searching for an insulating shellac to coat wires in electric motors and generators. Baekelund found that mixtures of phenol (C_6H_5OH) and formaldehyde (HCOH) formed a sticky mass when mixed together and heated, and the mass became extremely hard if allowed to cool and dry.

He continued his investigations and found that the material could be mixed with wood flour, asbestos, or slate dust to create "composite" materials with different properties. Most of these compositions were strong and fire-resistant. The only problem was that the material tended to foam during synthesis, and the resulting product was of unacceptable quality.

Baekelund built pressure vessels to force out the bubbles and provide a smooth, uniform product. He publicly announced his discovery in 1909, naming it "bakelite". It was originally used for electrical and mechanical parts, finally coming into widespread use in consumer goods in the 1920s. When the Bakelite patent expired in 1927, the Catalin Corporation acquired the patent and began manufacturing Catalin plastic using a different process that allowed a wider range of coloring.

Bakelite was the first true plastic. It was a purely synthetic material, not based on any material or even molecule found in nature. It was also the first "thermoset" plastic.

Conventional "thermoplastics" can be molded and then melted again, but thermoset plastics form bonds between polymers strands when "cured", creating a tangled matrix that cannot be undone without destroying the plastic. Thermoset plastics are tough and temperature resistant.

Bakelite was cheap, strong, and durable. It was molded into thousands of forms, such as radios, telephones, clocks, and, of course, billiard balls. The U.S. government even considered making one-cent coins out of it when World War II caused a copper shortage.

Phenolic plastics are still in widespread use. For example, some electronic circuit boards are made of sheets of paper or cloth impregnated with phenolic resin.

Polystyrene and PVC

After the First World War, improvements in chemical technology led to an explosion in new forms of plastics. Among the earliest examples in the wave of new plastics were "polystyrene" (PS) and "polyvinyl chloride" (PVC), developed by the I.G. Farben company of Germany.

Polystyrene is a rigid, brittle plastic that is now used to make plastic model kits, disposable eating utensils, and similar knicknacks. It would also be the basis for one of the most popular "foamed" plastics, under the name "styrene foam" or "Styrofoam". Foam plastics can be synthesized in an "open cell" form, in which the foam bubbles are interconnected, as in an absorbent sponge, and "closed cell", in which all the bubbles are distinct, like tiny balloons, as in gas-filled foam insulation and floatation devices.

```
 H        H              H     H     H     H
  \      /               |     |     |     |
   C == C       ->    -- C  -- C  -- C  -- C --
  /      \               |     |     |     |
 H       <bzr>           H   <bzr>   H   <bzr>

 styrene monomer        polystyrene polymer ("<bzr>" is a benzene ring)
```

PVC has side chains incorporating chlorine atoms, which form strong bonds. PVC in its normal form is stiff, strong, heat and weather resistant, and is now used for making plumbing, gutters, house siding, enclosures for computers and other electronics gear. PVC can also be softened with chemical processing, and in this form it is now used for shrink-wrap, food packaging, and raingear.

```
   H        H              H     H     H     H
    \      /               |     |     |     |
     C == C       ->    -- C  -- C  -- C  -- C --
    /      \               |     |     |     |
   H        Cl             H     Cl    H     Cl

 vinyl chloride monomer    polyvinyl chloride polymer
```

Nylon

The real star of the plastics industry in the 1930s was "polyamide" (PA), far better known by its trade name, "nylon". Nylon was the first purely synthetic fiber, introduced by Du Pont Corporation at the 1936 World's Fair in New York City.

In 1927, Du Pont had begun a secret development project designated "Fiber66", under

the direction of a Harvard chemist named Wallace Carothers. Carothers had been hired to perform pure research, and not only investigated new materials, but worked to understand their molecular structure and how it related to material properties. He took some of the first steps on the road to "molecular design" of materials.

His work led to the discovery of synthetic nylon fiber, which was very strong but also very flexible. The first application was for bristles for toothbrushes. However, Du Pont's real target was silk, particularly silk stockings.

```
          H    H    H    H    H    H              H    H    H    H
          |    |    |    |    |    |              |    |    |    |
-- N -- C -- C -- C -- C -- C -- C -- N -- C -- C -- C -- C -- C -- C --
   |    |    |    |    |    |    |    |    ||   |    |    |    |    ||
   H    H    H    H    H    H    H    H    O    H    H    H    H    O
```

nylon polymer chain

It took Du Pont twelve years and $27 million USD to refine nylon and develop the industrial processes for bulk manufacture. With such a major investment, it was no surprise that Du Pont spared little expense to promote nylon after its introduction, creating a public sensation, or "nylon mania". Nylon mania came to an abrupt stop at the end of 1941, when America entered World War II. The production capacity that had been built up to produce nylon stockings, or just "nylons", for American women, was taken over to manufacture vast numbers of parachutes for fliers and paratroopers. After the war ended, Du Pont went back to selling nylon to the public, engaging in another promotional campaign in 1946 that resulted in an even bigger craze, triggering off "nylon riots".

Nylon still remains an important plastic, and not just for use in fabrics. In its bulk form it is very wear-resistant, and so is used to build gears, bearings, bushings, and other mechanical parts.

Synthetic rubber

Another plastic that was critical to the war effort was "synthetic rubber", which was produced in a variety of forms.

Practical synthetic rubber grew out of studies published in 1930 written independently by Carothers and the German scientist Hermann Staudinger. These studies led in 1931 to one of the first successful synthetic rubbers, known as "neoprene". Neoprene is highly resistant to heat and chemicals such as oil and gasoline, and is used in fuel hoses and as an insulating material in machinery.

In 1935, German chemists synthesized the first of a series of synthetic rubbers known as "Buna rubbers". These were "copolymers", meaning that their polymers were made up from not one but two monomers, in alternating sequence. One such Buna rubber, known as "GR-S" ("Government Rubber Styrene), is a copolymer of butadiene and styrene, became the basis for US synthetic rubber production during World War II.

Worldwide natural rubber supplies were limited, and by mid-1942 most of the rubber-producing regions were under Japanese control. Military trucks needed rubber for tires, and rubber was used in almost every other war machine. The US government launched a major (and largely secret) effort to develop and refine synthetic rubber. A principal scientist involved with the effort was Edward Robbins.

By 1944 a total of 50 factories were manufacturing it, pouring out a volume of the material twice that of the world's natural rubber production before the beginning of the war.

After the war, natural rubber plantations no longer had a stranglehold on rubber supplies, particularly after chemists learned to synthesize isoprene. GR-S remains the primary synthetic rubber for the manufacture of tires.

Synthetic rubber would also play an important part in the space race and nuclear arms race. Solid rockets used during World War II used nitrocellulose explosives for propellants, but it was impractical and dangerous to make such rockets very big.

During the war, California Institute of Technology (Caltech) researchers came up with a new solid fuel, based on asphalt fuel mixed with an oxidizer, such as potassium or ammonium percholorate, plus aluminum powder, which burns very hot. This new solid fuel burned more slowly and evenly than nitrocellulose explosives, and was much less dangerous to store and use, though it tended to flow slowly out of the rocket in storage and the rockets using it had to be stockpiled nose-down.

After the war, the Caltech researchers began to investigate the use of synthetic rubbers instead of asphalt as the fuel in the mixture. By the mid-1950s, large missiles were being built using solid fuels based on synthetic rubber, mixed with ammonium perchlorate and high proportions of aluminum powder. Such solid fuels could be cast into large, uniform blocks that had no cracks or other defects that would cause nonuniform burning. Ultimately, all large military rockets and missiles would use synthetic rubber based solid fuels, and they would also play a significant part in the civilian space effort.

Plastics explosion: acrylic, polyethylene, etc

Other plastics emerged in the prewar period, though some wouldn't come into widespread use until after the war.

By 1936, American, British, and German companies were producing "polymethyl methacrylate" (PMMA), better known as "acrylic". Although acrylics are now well-known for the use in paints and synthetic fibers, such as "fake furs", in their bulk form they are actually very hard and more transparent than glass, and are sold as glass replacements under trade names such as "Plexiglas" and "Lucite". Plexiglas was used to build aircraft canopies during the war, and it is also now used as a marble replacement for countertops.

Another important plastic, "polyethylene" (PE), sometimes known as "polythene", was discovered in 1933 by Reginald Gibson and Eric Fawcett at the British industrial giant Imperial Chemical Industries (ICI). This material evolved into two forms, "low density polyethylene" (LDPE), and "high density polyethylene" (HDPE).

```
H          H               H     H     H
 \        /                |     |     |
  C  ==  C       ->    --  C --  C --  C --
 /        \                |     |     |
H          H               H     H     H

ethylene monomer       polyethylene polymer
```

PEs are cheap, flexible, durable, and chemically resistant. LDPE is used to make films

and packaging materials, while HDPE is used for containers, plumbing, and automotive fittings. While PE has low resistance to chemical attack, it was found later that a PE container could be made much more robust by exposing it to fluorine gas, which modified the surface layer of the container into the much tougher "polyfluoroethylene".

Polyethylene would lead after the war to an improved material, "polypropylene" (PP), which was discovered in the early 1950s by Giulio Natta. It is common in modern science and technology that the growth of the general body of knowledge can lead to the same inventions in different places at about the same time, but polypropylene was an extreme case of this phenomenon, being separately invented about nine times. It was a patent attorney's dream scenario, and litigation wasn't resolved until 1989.

Polypropylene managed to survive the legal process, and two American chemists working for Phillips Petroleum of the Netherlands, J. Paul Hogan and Robert Banks, are now generally credited as the "official" inventors of the material. Polypropylene is similar to its ancestor, polyethylene, and shares polyethylene's low cost, but it is much more robust. It is used in everything from plastic bottles to carpets to plastic furniture, and is very heavily used in automobiles.

```
 CH3          H            CH3    H    CH3    H
   \         /              |     |     |     |
    C  ==  C        ->   -- C  -- C  -- C  -- C --
   /         \              |     |     |     |
  H           H             H     H     H     H

propylene monomer         polypropylene polymer
```

Polyurethane was invented by Friedrich Bayer & Company of Germany in 1937, and would come into use after the war in blown form for mattresses, furniture padding, and thermal insulation. It is also used in non-blown form for sports wear as "lycra".

In 1939, I.G. Farben Industrie of Germany filed a patent for "polyepoxide" or "epoxy". Epoxies are a class of thermoset plastic that form cross-links and "cure" when a catalyzing agent, or "hardener", is added. After the war they would come into wide use for coatings, "adhesives", and composite materials.

Composites using epoxy as a matrix include glass-reinforced plastic, where the structural element is glass fiber, and "carbon-epoxy composites", in which the structural element is carbon fiber. Fiberglass is now often used to build sport boats, and carbon-epoxy composites are an increasingly important structural element in aircraft, as they are lightweight, strong, and heat-resistant.

Two chemists named Rex Whinfield and James Dickson, working at a small English company with the quaint name of the "Calico Printer's Association" in Manchester, developed "polyethylene terephthalate" (PET or PETE) in 1941, and it would be used for synthetic fibers in the postwar era, with names such as "polyester", "dacron", and "terylene".

PET is more impermeable than other low-cost plastics and so is a popular material for making bottles for Coca-Cola and other "fizzy drinks", since carbonation tends to attack other plastics, and for acidic drinks such as fruit or vegetable juices. PET is also strong and abrasion resistant, and is used for making mechanical parts, food trays, and other items that have to endure abuse. PET films, tradenamed "Mylar®", are used to make recording tape.

One of the most impressive plastics used in the war, and a top secret, was "polytetrafluoroethylene" (PTFE), better known as "teflon", which could be deposited on metal surfaces as a scratchproof and corrosion-resistant, low-friction protective coating. The polyfluoroethylene surface layer created by exposing a polyethylene container to fluorine gas is very similar to teflon.

A Du Pont chemist named Roy Plunkett discovered teflon by accident in 1938. During the war, it was used in gaseous-diffusion processes to refine uranium for the atomic bomb, as the process was highly corrosive. By the early 1960s, teflon "non-stick" frying pans were a hot consumer item.

```
    F         F                  F    F    F
     \       /                   |    |    |
      C == C           ->     -- C -- C -- C --
     /       \                   |    |    |
    F         F                  F    F    F

tetrafluoroethylene monomer      teflon polymer
```

Teflon was later used to synthesize the miracle fabric "Gore-Tex", which can be used to build raingear that in principle "breathes" to keep the wearer's moisture from building up. GoreTex is also used for surgical implants; teflon strand is used to make dental floss; and teflon mixed with fluorine compounds is used to make "decoy" flares dropped by aircraft to distract heat-seeking missiles.

After the war, the new plastics that had been developed entered the consumer mainstream in a flood. New manufacturing were developed, using various forming, molding, casting, and extrusion processes, to churn out plastic products in vast quantities. American consumers enthusiastically adopted the endless range of colorful, cheap, and durable plastic gimmicks being produced for new suburban home life.

One of the most visible parts of this plastics invasion was Earl Tupper's "tupperware", a complete line of sealable polyethylene food containers that Tupper cleverly promoted through a network of housewives who sold Tupperware as a means of bringing in some money. The tupperware line of products was well thought out and highly effective, greatly reducing spoilage of foods in storage. Thin-film "plastic wrap" that could be purchased in rolls also helped keep food fresh.

Another prominent element in 1950s homes was "Formica®", a plastic laminate that was used to surface furniture and cabinetry. Formica was durable and attractive. It was particularly useful in kitchens, as it did not absorb, and could be easily cleaned of stains from food preparation, such as blood or grease. With formica, a very attractive and well-built table could be built using low-cost and lightweight plywood with formica covering, rather than expensive and heavy hardwoods like oak or mahogany.

Composite materials like fiberglass came into use for building boats and, in some cases, cars. Polyurethane foam was used to fill mattresses, and styrofoam was used to line ice coolers and make float toys.

Plastics continue to be improved. General Electric introduced "lexan", a high-impact "polycarbonate" plastic, in the 1970s. Du Pont developed "kevlar", an extremely strong synthetic fiber that was best-known for its use in bullet-proof vests and combat helmets. Kevlar was so remarkable that Du Pont officials actually had to release statements to deny rumors that the company had received the recipe for it from space aliens.

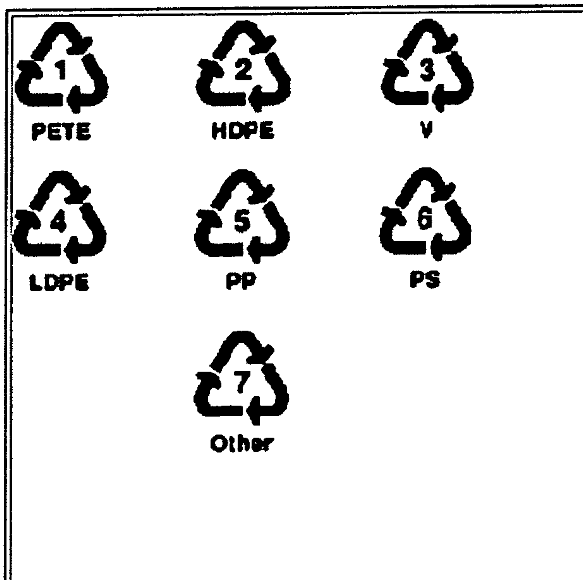
The environment

Although plastics have had a remarkable impact on our culture, it has become increasingly obvious that there is a price to be paid for their use.

Plastic was almost too good, as it was durable and degraded very slowly. In some cases, burning it could release toxic fumes. Also, the manufacturing of plastics often created large quantities of chemical pollutants, and required use of the Earth's limited supply of fossil fuels. However, it should be noted that plastics only consume 4% of world's oil production. Furthermore, it can be claimed that the use of plastics helps the environment by saving water and oil. For example, plastics make cars lighter, thus saving oil and reducing CO_2 emissions.

By the 1990s, plastic recycling programs were common in the United States and elsewhere. Thermoplastics can be remelted and reused, and thermoset plastics can be ground up and used as filler, though the purity of the material tends to degrade with each reuse cycle. There are methods by which plastics can be broken back down to a feedstock state.

To assist recycling of disposable items, the Plastic Bottle Institute of the Society of the Plastics Industry devised a now-familiar scheme to mark plastic bottles by plastic type. A recyclable plastic container using this scheme is marked with a triangle of three "chasing arrows", which enclose a number giving the plastic type:



Plastics type marks

1. PETE - Polyethylene Terephthalate, Commonly found on: 2-litre soft drink bottles, cooking oil bottles, peanut butter jars.
2. HDPE - High Density Polyethylene, Commonly found on: detergent bottles, milk jugs.
3. PVC - Polyvinyl Chloride, Commonly found on: plastic pipes, outdoor furniture, shrink wrap, water bottles, salad dressing and liquid detergent containers.
4. LDPE - Low Density Polyethylene, Commonly found on: dry cleaning bags, produce bags, trash can liners, food storage containers.
5. PP - Polypropylene - , Commonly found on: bottle caps, drinking straws
6. PS - Polystyrene, Commonly found on: packaging pellets or "Styrofoam peanuts," cups, plastic tableware, meat trays, take away food clam shell containers
7. OTHER - This plastic category, as its name of "other" implies, is any plastic other than the named #1-#6, Commonly found on: certain kinds of food containers and Tupperware.

Unfortunately, recycling plastics proved difficult. The biggest problem with plastics recycling is that it is difficult to automate the sorting of plastic waste, and so it is labor-intensive. While containers are usually made from a single type and color of plastic,

making them relatively easy to sort out, a consumer product like a cellular phone may have many small parts consisting of over a dozen different types and colors of plastics. As the value of the material is low, recycling plastics is unprofitable. For this reason, the percentage of plastics recycled in the US is very small, somewhere around 5%. Even so the American Plastics Council spends about 20 million dollars a year on an ad campaign that tries to convince the public that plastic recycling works.

Recently it was shown, however, that for post-consumer plastic waste, gasification offers a solution for the recycling of such material.

Research has been done on "biodegradable" plastics that break down with exposure to sunlight. Starch can be mixed with plastic to allow it to degrade more easily, but it still doesn't lead to complete breakdown of the plastic. Some researchers have actually genetically engineered bacteria that synthesize a completely biodegradable plastic, but this material is expensive at present. BASF make Ecoflex, a fully biodegradable polyester for food packaging applications. The disadvantage of biodegradable plastics is that the carbon that is locked up in them is released into the atmosphere as the greenhouse gas carbon dioxide when they degrade.

So far, these plastics have proven too costly and limited for general use, and critics have pointed out that the only real problem they address is roadside litter, which is regarded as a secondary issue. When such plastic materials are dumped into landfills, they can become "mummified" and persist for decades even if they are supposed to be biodegradable. In this regard though plastics are no worse than food or paper which also fails to degrade in landfills.

There have been some success stories. The Courtauld concern, the original producer of rayon, came up with a revised process for the material in the mid-1980s to produce "Tencel". Tencel has many superior properties over rayon, but is still produced from "biomass" feedstocks, and its manufacture is extraordinarily clean by the standards of plastic production.

Price and the future

One of the great appeals of plastics have been their low price, as compared to other materials. However, in recent years the cost of plastics has been rising dramatically. The cause of the increase is the sharply rising cost of petroleum, the raw material that is chemically altered to form commercial plastics. As the cost of plastic hinges on the cost of petroleum, should petroleum prices continues to rise, so will the cost of plastic. In 2004, the higher price of plastic drove a number of plastic toy manufacturers out of business.

Fears of dwindling petroleum supplies are becoming very real, with publications such as USA Today reporting that current oil reserves will only last 40 years. Alternate reserves such as oil shale and tar oil (tar sand) do exist, but the cost of production is much higher than with current sources. Thus, even if alternative sources are used, costs will continue to rise.

Scientists are seeking cheaper alternatives to plastic. Some plastic alternatives are: graphite, fiberglass, carbon fiber, graphene, carbon nanotubes, diamond, aerogel, carbon nanofoam, cellulose soybean plastic (bioplastic), and other carbon-based non-petroleum materials. Some of these alternatives are too expensive or not malleable enough, but can be used in some plastic applications. Some are many times the strength of plastic, but crack if made thin like cellophane. The most promising alternatives to plastic are graphene, carbon nanotube, and carbon nanofoam. All three of these are made of nanocarbons, products of the new nanotechnology. Nanocarbons are very cheap, 100

times stronger than steel, slicker than Teflon, lightweight, and can be made very thin, made to stretch, and built into any shape - all the things plastic can do. In addition, nanocarbon manufacturing is low- to non-polluting. Already bowling balls, golf balls, sports equipment, and water-proof cotton balls have been made of nanocarbons.

Common plastics and their typical uses

polyethylene (PE)
: wide range of uses, very inexpensive

polypropylene (PP)
: food containers, appliances

polystyrene (PS)
: packaging foam, food containers, disposable cups, plates and cutlery

polyethylene terephthalate (PETE)
: beverage containers

Polyamide (PA) (Nylon)
: fibres, toothbrush bristles, fishing line

polyester
: fibres, textiles

polyvinyl chloride (PVC)
: plumbing pipes, flooring

polycarbonate
: compact discs, eyeglasses

acrylonitrile butadiene styrene (ABS)
: electronic equipment cases (e.g. computer monitors, printers, keyboards)

polyvinylidene chloride (PVDC) (Saran)
: food packaging

Special purpose plastics

Teflon
: heat resistant, low-friction coatings

Polyurethane
: insulation foam, upholstery foam

Bakelite
: insulating parts in electrical fixtures (strictly speaking not a plastic, but a ceramic material using a phenol formaldehyde resin binder)

See also

- Injection moulding
- Polymer
- Synthetic fiber
- Timeline of materials technology
- Plastics engineering

External links

- http://www.pslc.ws/mactest/index.htm

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Other uses of this term include: plasticity, the property

Translations
Translations for: Plastic

Nederlands (Dutch)
plastic, betaalpassen, soepel, beïnvloedbaar, kneedbaar, zich kunnende aanpassen, scheppend, beeldend, van plastic, betreffende plastische chirurgie, kunstmatig

Français (French)
plastique, malléable, synthétique, illustrations

Deutsch (German)
n. - Plastik, Kunststoff, Plast(werkstoff)
adj. - plastisch, formbar, Plastik-, Kunststoff-

Ελληνική (Greek)
n. πλαστικό (υλικό ή αντικείμενο), πλαστικό χρήμα adj. πλαστικός, εύπλαστος, ανήκων ή αναφερόμενος στις πιστωτικές κάρτες, εικαστικός

Italiano (Italian)
plastica, plastico, figurativo

Português (Portuguese)
n. - plástico
adj. - plástico, maleável

Русский (Russian)
пластик, пластичный, пластиковый, гибкий, неестественный

Español (Spanish)
n. - plástico, gráfico
adj. - moldeable, sintético, gráfico, de plástico

Svenska (Swedish)
n. - plast
adj. - plast-, plastisk, smidig, formbar, plastik, ytlig, konstlad

中国话 (Simplified Chinese)
n. - 塑胶, 信用卡, 塑胶制品
adj. - 塑胶的, 有可塑性的, 塑造的

中國話 (Traditional Chinese)
n. - 塑膠, 信用卡, 塑膠製品
adj. - 塑膠的, 有可塑性的, 塑造的

日本語 (Japanese)

n. - プラスチック, プラスチック製品
adj. - 形を造る, 生活組織を形成する, 塑造できる, プラスチックの, 造形的な, 人工的な, にせものの, 温順な, 可塑性の

العربيه (Arabic)
(الاسم) مكون, مبدع, طيع, مطواع, لين, اللدائن, البلاستيك (صفه) لدائني

עברית (Hebrew)
n. - חומר פלסטי
adj. - פלסטי, נוח לעיצוב, גמיש, מושפע בנקל, בר-שינוי, של כיור

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To select your translation preferences click here.

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plastic is mentioned in the following topics:

PDIP (technology)	PPGA (technology)
plastique	-plastic (suffix)
PQFP (technology)	blepharoplasty
clothespin	dishware
Lurex (trademark)	paper clip
	More>

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Medical definition of **plastic**

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